UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION – KUMASI

DESIGN AND CONSTRUCTION OF GENERATOR TIMER SWITCH

JOSEPH SAM

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A DISSERTATION IN THE DEPARTMENT OF ELECTRICAL/ELECTRONICS DEPARTMENT,FACULTY OF TECHNOLOGY, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNVERSITY OF EDUCATION,WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR AWARD OF THE MASTER OF TECHNOLOGY(ELECTRICAL/ELECTRONICS) DEGREE

DECEMBER, 2017

DECLARATION

STUDENT'S DECLARATION

I, Joseph Sam, declare that this dissertation with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere

SIGNATURE……………………………………………..

DATE…………………………………………………..

SUPERVISOR'S DECLARATION

I, hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines of supervision of Dissertation as laid down by the University of Education Winneba

NAME OF SUPERVISOR……………………………………………..

SIGNATURE………………………………………………………………….

DATE…………………………………………………………………………

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Finally, I thank my colleagues, Alexander Kyereh, Godfred Bonsu and George Dzime for their encouragement

DEDICATION

This work is dedicated to my family

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ABSTRACT

The ability to supply power to consumer loads is one of the primary aims of the utility companies. In Ghana and other developing countries, power has not been sent to the door steps of every consumer. This has called for an alternative means of prolongs electricity. One of the most common alternative source of power in Ghana is by using alternator (generator) Because of the excessive noise produce by these generators and carbon monoxide, they are positioned a little a bit far away from where the consumer works or sleeps. When a consumer needs to put off this generator, he/she has to walk from the room all the way to where the generator is to put is off.

This project sough to switch off the generator automatically when the preset time set by the consumer is due. This system also switched off the generator when the set time is not due but when the fuel had dropped to the lowest level and again an alarm system is incorporated to warn to user that there is shortage of fuel. Based on technological advancement various theories have been implemented to design different kinds of means to attain automatic timers for many applications.

In this paper, a generator timer switch was designed using CD4060 integrated circuit. 555timer, ua741, Ca3140μ, 4020BP integrated circuit and other components to achieve the whole functionality. The experiment was conducted in my house with the help of a generator. The circuit was initially set to go OFF at exactly one hour time of which it went off at one- hour two minutes. It was also tested for different set times.

The generator went off immediately the fuel falls below the minimum level, then the busser sounds an alarm to prompt the user that there is shortage of fuel.

Results proved that the system works perfectly with variation of only two minutes in switching OFF time. Based on this results the following conclusion could be made, the generator timer

switch was constructed with local materials was able to switch OFF the generator at the pre-set time. It was able to put off the generator a pre-set time. It was able to put off the generator when the fuel level falls below the minimum and also sound an alarm and finally the production cost was low since it uses locally available components. I therefore recommend that the government of Ghana should encourage Ghanaians to embrace locally manufactured goods in order to improve technology and also built ultra- modern laboratories for schools.

CHAPTER ONE

1.1 Background to the study

In modern society where almost everything is run by electricity, homes and industries alike heavily rely on electricity to perform different tasks. There are automated electrical machines in industries, homes, and businesses which require constant reliable power supply as power outages would disrupt the flow of productivity or damage the machines and in effect cause financial loss to companies and individuals. In order to avoid interruption of work flow to ensure maximum production, a standby power supply is needed to augment power supply in case of power outage. Generators are used to supply temporal power in case of power outages.

Disruption in power supply occurs as a result different circumstances. Weather patterns can disrupt power supply. Weather patterns all around the world have dramatically changed over the years. During heavy rainfall, storms, and extreme weather conditions such as droughts, power supply is disrupted.

During disruptions in power supply, most people rely on generators as a backup power source. Generators are machines that convert mechanical energy into electrical energy. Hence, consumers can have access to electrical power through generators when there is power outage. Though most generators used in homes do not have the same power capacity as those used in industries, they can power some selected appliances. A generator can also be connected directly into the electrical system of a home in order to prevent power outage. It can be automated to switch on when there is power outage. There are two types of generators on the markets, these are portable and stand-by. Portable generators can be carried or transported for use in different places while stand-by generators are permanently fixed at a location. Portable generators can be used during camping, construction and at home when it is used to power certain appliance from different parts of the house. Stand-by generators are those that are installed permanently outside the premise and cannot be moved or carried. Though generators are very useful in that they provide much needed electricity it is also important to conserve energy in order to reduce cost. Hence it is necessary for a switch timer to be developed to regulate the operational time of a generator. This will ensure that the generator is automatically switched off at a specified time. Users will as a result not have to worry about manually switching it off especially at night or during rainy days. Also, users will not have to inhale the toxic fumes which generators produce when they are switched on or are in operation.

The fumes produced are harmful to the health of users and can affect their lungs. Hence, eliminating human involvement in the operation of generators will help to protect the health of users. The microscopic particles in petrol exhaust are less than one-fifth the thickness of a human hair and are small enough to penetrate deep into the lungs, where it can contribute to a range of health problems. Carbon monoxide (CO) is a byproduct of gasoline combustion in generators and can negatively affect the safety and health of the user. As a result the need to design and construct a timer that can automatically switch on or put off generators.

A timer is an electronic device which is used for producing time delay intervals for switching a connected load. The delay time is set externally and is controlled by the user as per the requirement.

http://www.chip1stop.com/web/HKG/en/tutorialContents.do?page=080

The switch is made in such a way that when there is no fuel in the generator during operation, the generator would be switched off even if the stipulated time set by the user is not due. The fuel level indicator is utilized to prevent the generator from breaking down when it experiences shortage in fuel. The switch indicator is made such that it determines when the generator should be switched off when there is no fuel in the generator.

A simple timer can be built through many countless options. The following options can be use transistors, CMOS gates like NAND gates, NOT gates, linear ICs like 555, 741, 324, or specific types of CMOS IC like the 4060 may be used. All these devices basically generate oscillations which are adjustable right from a few Hz of a second to an atomic fraction of a Hz.

1.2 Statement of the Problem

It is inconvenient for users of generators to always switch them off manually, hence the need to construct a switch to automatically switch OFF a generator after a stipulated time period provided by the user. This will also protect users from inhaling the toxic fumes that generators emit.

1.3 Objectives of the Study

1. To design and construct a timing switch to automatically put off a generator at a specified time.
2. To prevent generator users from inhaling the exhaust fumes produced by generators.
3. To conserve energy, since all work or activities have to be planned before the generator is timed.

1.4 Research Questions

In order to achieve the objectives of this project, the following research questions were asked:

1. How can a user switch off a generator without manually accessing it?
2. How can energy be saved using a timer switch to switch off a generator?
3. How can a user be prevented from inhaling the fumes produced by generators when switching it off?

1.5 Significance of the Study

This project will enable people to automatically switch off their generators without manually accessing them, therefore prevent the inhalation of exhaust fumes from petrol generators.

1.6 Scope of the Study

The main focus of this project was to design a timer switch to automatically switch off generators at a scheduled time.

1.7 Organization of the study

This project is organized into five chapters. Chapter One provides an introduction for the study while Chapter Two focuses on the literature review which examines the design of a timer switch device for electrical appliances and generators. Methodology is discussed in Chapter Three while Chapter Four focuses on the testing and results obtained from the timer switch. Chapter Five presents the conclusion and recommendations for the project.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Timer

A timer, according to Merriam-Webster dictionary, is a specialized type of clock used for measuring time intervals. Times and timing circuits are very important in daily activities and their applications are numerous. Timers can be found in washing machines, television sets, fans, water pumping machines, Compact disk players, school sirens and many others areas.

Types of timers

Mechanical timers

Mechanical timers use clock wave to measure time. The timers are typically set by timing a dial to the time interval desired. Turning of the dial stores energy in a mainspring to run the mechanism (Sobery.)

Electromechanical timers

Short period bimetallic electromechanical timers use a thermal mechanism with a metal finger made of strips of two metals which have different rates at thermal expansion and are sandwiched together. An example of the electromechanical timer is steel and bronze. An electric current flowing through this figure causes heating of the metals, one side expands more than the other and an electrical contact on the end of the figure moves away from or towards an electrical switch contact. The most common use of this type is in the "flasher" unit that flashes as turn signals in automobile and flashes in Christmas lights.

http://en.wikipedia.org/wiki/Timer#Electromechanical_timers

Electric timers

An electric timers is a type of relay that carries out opening or closing of a contact often the clasping a predetermined time interval upon receiving the signal

Electrical timers are essentially quart clocks with special electronics and can achieve higher precision than mechanical timers. Electronic timers have digital electronics but may have an analogue or digital display. Individual timers are implemented as a simple single-chip computer system, similar to what is used in watches. Many timers are now implemented in software form. Modern controllers use a programmable logic controller rather than a box full of electromechanical parts. The logic is usually designed as though it were relays using a special computer programming language called ladder logic. In PLCs, timers are usually simulated by a software built into the controller. Each timer is as a result just an entry in a table run by the software. http://en.wikipedia.org/wiki/Timer#Electromechanical_timers

Fuel Level or Gas Indicators

A fuel gauge or gas gauge is an instrument used in a tanks. They are commonly used in most motor vehicles and this may also be used for any tank including underground storage tanks. There are many ways of displaying the level of fuel or gas in tanks. Fuel level can be displayed either digitally or by use of analogue. There are situations where an alarm is sounded as an indication of a drop in fuel level to the lowest point allowed. Erjavec (2000).

Vehicles use a fuel level indicator (fuel gauge) to show fuel levels. The fuel gauge used in vehicles consists of two parts; the sensing unit and the indicator unit. The sensing unit usually uses a float connected to a potentiometer, typically printed ink design in a present automobile. As the tank empties, the float drops and then slides a moving contact along the resistor to increase its resistance. Additionally, when the resistance reaches a certain level, it turns “ON” or flashes a light to indicate “low fuel” in some vehicles. Most new cars have an arrow on the fuel gauge. This arrow indicates the fuel level in the car. The indicator unit is usually mounted on the dashboard to measure and display the amount of electric current flowing through the sending unit. When the tank level is high with maximum current flowing through, the needle points to “F” which indicates a full tank. When the tank is empty and the least current is flowing, the needle points to “E” indicating an empty tank.

In his view, Mohankumar (2012) proposes a different fuel reserve indicator for vehicles. This fuel indicator is a simple circuit that monitors the fuel level in vehicles. It gives an audio visual indicator when the fuel level alarmingly drops below the reserve level to ensure that the vehicle does not run out of fuel.

Direct Current Power Supply Unit

A D/C power supply is one that supplies a voltage of foxed polarity (either positives or negative) to its loads. Depending on its design, a D/C load may be powered from a battery, solar panel, fuel cells or from an A/C source such as the national grid.

D/C power supplies use A/C mains electricity as an energy source. Such power supplies will sometimes empty a transformer to convert the input voltage to a high or lower A/C voltage. A rectifier is then used to convert the transformer output voltage to a varying D/C voltage, which is in turn passed through an electronic filter to convert it to an unregulated D/C voltage. The filter removes most but not all of the AC ripples in the supply.

In some applications like battery charging, high ripple is tolerated and therefore no filtering is required. However, in areas where constant voltages are required, linear regulators are employed to count the varying D/C voltage to constant voltage. In addition, they often provide a current limiting function to protect the power supply and load from over current.

A constant output voltage is required in many power supply applications, but voltage provided by many energy sources vary with changes in load impedance. Some power supplies use output voltage at a steady value independent of fluctuations in input voltage and load impedance.

2.2 SOME TIMING CIRCUITS PROPOSED BY RESEARCHERS

Sureshkumar (2005) proposed an automatic – off timer for Compact disk players. He proposed this type of timer to help put off Compact disk players after their listeners had fallen asleep to perhaps aid in energy conservation and to reduce noise pollution. This system functioned when someone switched off the bedroom light by automatically turning off the Compact disk player at a predetermined time. In the presence of ambient light, or when light is switched on the next day, the Compact disk player switches on and plays.

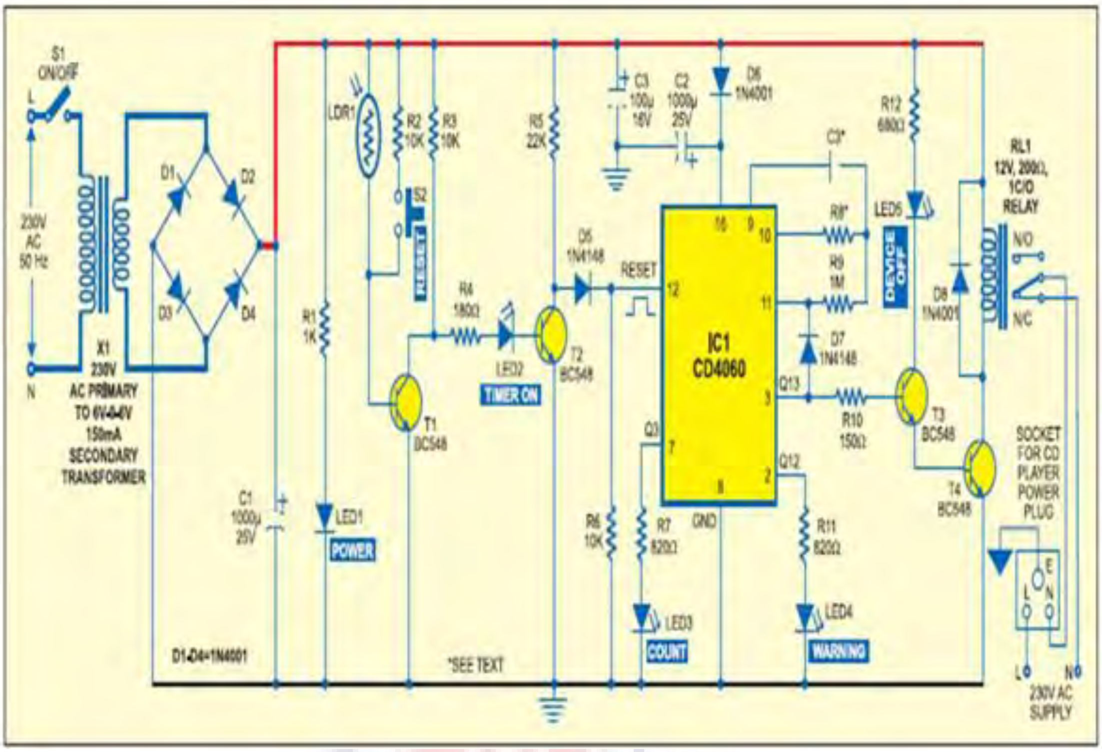

Figure 2.1 shows the circuit diagram of the automatic –off timer for CD players. The circuit is powered by a 240V to 12V step down transformer. When the 'on'/'off' switch (S1) is closed, LED1 glows to indicate that the circuit is powered 'on.' In the presence of light, the resistance of the light-dependent resistor (LDR1) is low, so transistor T1 conducts to drive transistor T2 into cut off state while the timer circuit remains inactive. The collector of transistor T2 is connected to reset pin 12 of IC CD4060 (IC1) through signal diode D5. IC CD4060 is a 14-stage ripple counter with a built-in oscillator. The time period of oscillations (t) is determined by capacitor C3 and resistor R8 connected to pins 9 and 10 of IC1, respectively, as follows:

t=2.3RC where 'R' is the value of resistor R8 and 'C' is the value of capacitor C3. When transistor T2 is cut-off, its collector voltage is high, so pin 12 of IC1 is high and IC1 is in reset condition. When the light is switched off, the resistance of LDR1 increases which in turn drives transistor T1 into cut-off state. The collector voltage of transistor T1 goes high to light up LED2 indicating that the timer circuit is enabled and transistor T2 starts conducting. As the collector voltage of transistor T2 lowers to around 0.2V, ground potential becomes available at reset pin 12 of IC1. The low state at pin 12 enables the oscillator to start counting. LED3 at pin 7 of IC1 starts blinking. Its blinking frequency depends on the R-C components connected between its pins 9 and 10. The status of LED2 and LED3 in the circuit with light falling and not falling on LDR1 is given as follows, during counting, in case the power fails momentarily, capacitor C2 (1000µF) will provide the necessary power backup for IC1. That is, during the period, pin 3 of IC1 is low. When output pin 3 of IC1 goes high, the relay is energized through transistors T3 and T4 and, at the same time, counting is disabled by the feedback from pins 3 through 11 (clock input) of IC1 through signal diode D7. That is, due to the feedback, output pin 3 remains high unless another high-to-low pulse is received at its reset pin 12. After the relay is energized, there will be no AC power in the socket. The glowing of LED5 indicates that the CD player has been switched off. The desired 'off' time period for the timer circuit can be set by choosing proper values of resistor R8 and capacitor C3. If R8 is 680 kilo-ohms and C3 is 0.22 µF, the 'off' time period is around 45 minutes. The glowing of LED4 gives an indication that the CD player is going to be switched off shortly. In case one wants to extend the timer setting for another round, just press reset switch S2 momentarily. LED4 stops glowing and counting starts again from the initial stage.

http://www.electronicsforu.com/electronicsforu/circuitarchives/view_article.asp?sno=222&article_type=1&id=365&tt=unhot

Tarun Agarwal (2013) proposed a battery charger with a timer to switch off a charging process after 24 hours. Figure 2.4 shows the circuit diagram.

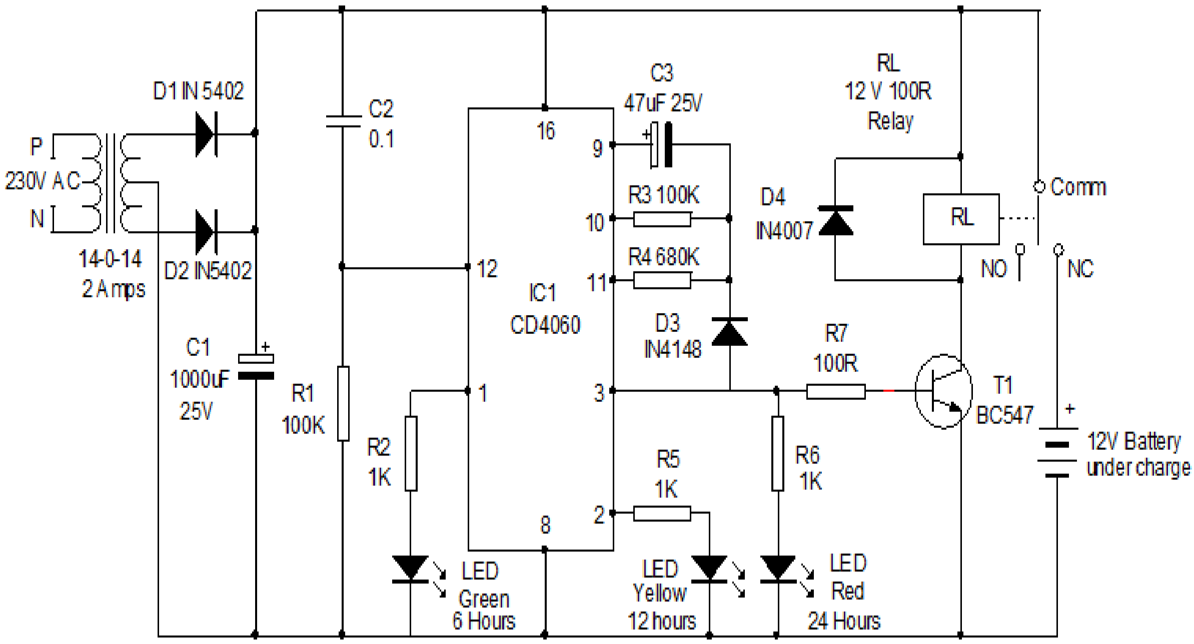

Figure 2.2: circuit diagram of battery charger with timer

A 14-0-14 volts 2 amperes step-down transformer is used to drop the 230 volts AC to 14 volts AC. The low volt AC is rectified to DC by the diodes D1 and D2 which can handle 2 amps of current. The rectified DC is then made ripple free by the smoothing capacitor C1. A 24 hour timer circuit is built around IC1 (CD4060) which is a binary counter IC with ripple cascade arrangement. It starts the timing cycle provided its reset pin 12 is low. The IC has 10 outputs which become high one by one depending on the values of the timing capacitor at pin 9 and timing resistor at pin 10. The pulses are fed to the clock input pin 11. Due to binary counting of the IC, each output turns high after a period double than the previous one and the output remains high for that entire period. If the high output is fed back to the clock input through a diode, the IC stops oscillating and the particular output remains high till the IC resets. The reset pin12 is connected to the junction between C2 and R1 so that IC resets at power on and starts oscillating. After 6 hours, pin 1 of the IC becomes high and the Green LED turns on. After 12 hours, pin 2 turns high and the yellow LED turns on which indicates half time. After

24 hours, pin 3 turns high and the relay triggers to cut off the charging process. At the same time, diode D3 conducts and inhibits the oscillation of IC so that the relay remains energized till the power is switched off. Red LED indicates the activation of relay and the termination of the charging process. By changing the value of C3 or R3, it is possible to increase or decrease the timing.

Transistor T1 is the relay driver. A 12 volt relay is used to provide charging current to the battery through its common and normally connected (NC) contacts. So that when the relay is in the off position, the battery will get charging current and when the relay triggers, charging terminates. Diode D4 protects T1 from back e.m.f when T1 switches off.

Chaudhary (2013), on the other hand, proposed proposes an electronic washing machine control that has a timer circuit which can be set to any duration from 0 to 15 minutes and can be extended to any length of time by merely changing a capacitor. The circuit has switching circuits which run the impeller in one direction for 25 seconds and then stops the motor for five seconds. This cycle repeats until the time set in the timer is elapsed. An optional switch is provided to select normal/strong washes. During ‘normal’ washing, the impeller rotates in both directions alternatively with five second gaps between reversals. This type of wash is suitable for delicate clothes. During ‘strong’ washing, the impeller rotates in one direction only with five second which push after every 25 seconds. In this mode, the impeller rotates in one direction only continuously. This mode is suitable for blankets, rugs and other heavy clothes.

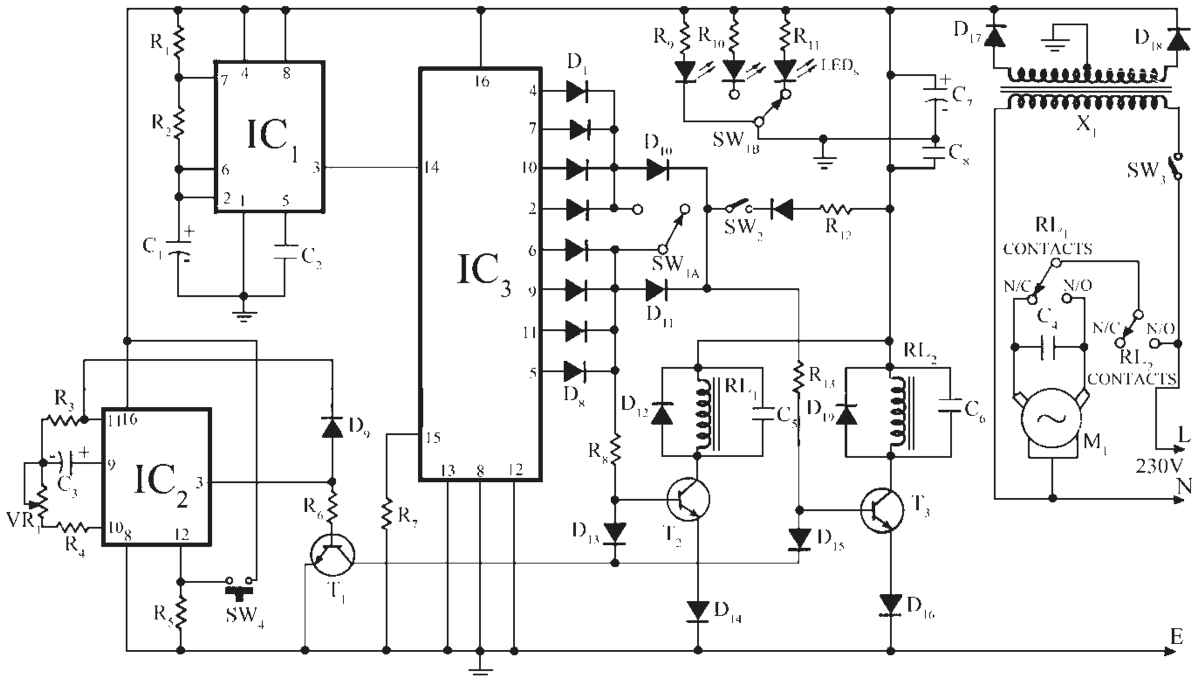

Figure 2.3 is the circuit diagram of the electronic washing machine control timer

The heart of the circuit is IC_3 which is a CMOS decade counter cum decoder. The IC provides ten outputs which go high one at a time for every clock pulse applied at pin 14. The clock pulses are obtained by IC_1 NE555 wired in as table multi-vibrator mode. The second, third, fourth and fifth outputs are OR'ed by four 1N4148 diodes ($D_1 – D_4$). Similarly, the 7^{th}, 8^{th}, 9^{th} and 10^{th} outputs are OR,ed by another four 1N4148 diodes (D_5 – D_8). The first and sixth outputs are left unused.

When IC_3 starts counting, the first pulse is not received by any diode, and during that period transistors T_3 and T_2 are switched off and the relays are also switched off, disabling the motor. During counts from second to fifth pulse T_3 is turned on while T_2 is switched off. The motor runs in one direction for four clock pulses. During the sixth pulse, once again T_3 and T_2 are turned off and the motor stops. During seventh to tenth pulses, T_3 and T_2 are put on while the motor runs in the opposite direction due to switching of winding by relay RL_1 contacts.

The timer is based on IC_2 CD4060 which divides by 16384 counters. The timer can be set by 1M potentiometer. After the set-time T_1 switches T_2 and T_3 off, thus disabling the motor. The 4060 can be reset by the push-to-on switch provided.

Capacitor C_4 is a starting capacitor already fixed to the motor. Relay RL_1 and RL_2 are 6V, 100 Ω, 6A rated relays.

Note: SW_1 = Normal/Strong Selector

SW_2 = Continuous Selector

SW_4 = Reset

PARTS LIST

COMPONENTS	VALUE
Resistors	Resistors (all ¼-watt, ± 5% Carbon)
Resistor, R_1, R_6	1 kilo ohms
Resistor, R_2, R_4	100 kilo ohms
Resistor, R_3	1 mega ohms
Resistor, R_5	4.7 kilo ohms
Resistor, R_7	10 kilo ohms
Resistor, R_8, R_{12}, R_{13}	470 ohms
Resistor, R_9, R_{10}, R_{11}	750 ohms
Variable Resistor	1 mega ohms Lin
Capacitors	
C_1	47 µF/ 25 V
C_2, C_5, C_6	0.01 µF
C_3	1 µF / 25 V
C_6	1000 µF/ 25 V
C_8	0.1 µF
Semiconductors	
IC_1	NE555
IC_2	CD 4060
IC_3	CD 4017
Transistor	
T_1 –T_3	BC148B
Diodes	

$D_1 – D_{11}$, D_{13}, D_{15}	1N4148
D_{12}, D_{14}, $D_{16} – D_{19}$	1N4001
Transformer	
X_1	220V C primary to 9V-0-9V 500mA secondary transformer
M	230V AC, ¼ HP reversible induction motor
Relays	
RL_1, RL_2	6V, 100Ω
Switches	
SW_1	DPDT switch (Normal/Strong Selector)
SW_2	SPST Switch (Continuous Selector)
SW_3	ON/OFF switch
SW_4	Push-To-On switch (Reset

Table 2.1 showing the part list of the washing machine controller timer

http://bestengineeringprojects.com/electronics-projects/electronics-washing-machine-control-circuit-diagram

Fridge Timer

Furthermore, Agarwal (2012) proposes a fridge timer circuit which automatically switches OFF the fridge during peak hours (6pm to 8:30pm) and switches ON after two and half hours in order to save energy. The figure below (figure 2.3) shows the fridge timer circuit.

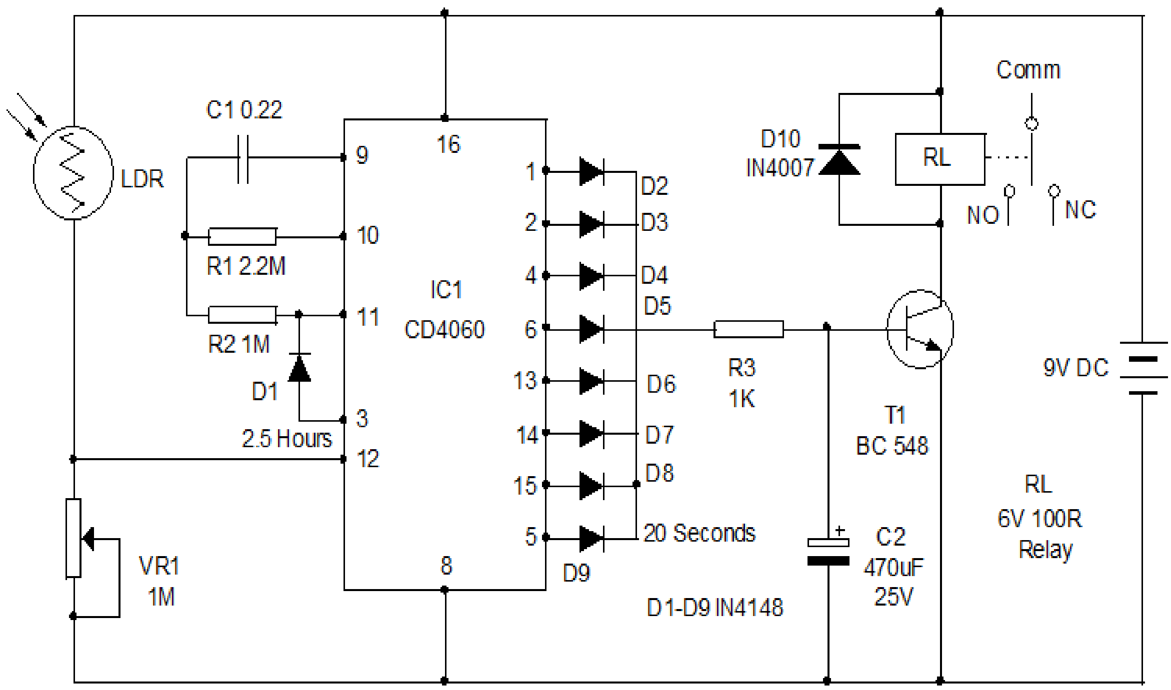

Figure 2.4: circuit diagram of a fridge timer

An LDR is used as a light sensor to detect nightfall or darkness around 6 pm. During day light, LDR has less resistance and it conducts. This keeps the reset pin 12 of IC1 high and the IC remains off without oscillating. VR1 adjusts the resetting of IC at a particular light level in the room, say around 6 pm. When the light level in the room drops below the preset level, IC1 starts oscillating. After 20 seconds, its pin 5 turns high and triggers the relay driver transistor T1. The power supply to the fridge is provided through the Comm and NC contacts of the relay. So when the relay triggers, the contacts break and the power to the fridge is cut off.

The other outputs of the IC1 turns high one by one as the binary counter advances. But since the outputs are taken to the base of T1 through the diodes D2 through D9, T1 remains on during the entire period until the output pin 3 turns high after 2.5 hours. When the output pin 3 turns high, diode D1 forwards biases and inhibits the oscillation of IC. At this time, all the outputs except pin 3 turn low and T1 switches off. Relay reenergizes and the fridge regains power through the NC contact. This condition remains as such till the LDR gets light again in the morning. IC1 then resets and pin3 again turns low, so that the fridge works during the day. The fridge is switched off only during the peak hours; between 6 pm and 8.30 pm. When the value of either C1 or R1 increases the time is delayed to 3 or 4 hours.

Additionally, Saracin, (2015) propose a preset timer or an automatic transfer switch for a modified alarm system which has capability to monitor and report electrical faults which occur in the power grid of vital consumers such as hospitals, HVAC (heating, ventilation and air conditioning), safety lighting, security locks of gates and doors to a cell phone or tablet. They are electric power supply drawn from independent sources of electricity connected to the national power system in distinctive points or from dedicated emergency electric sources (dedicated power generators). The alarm system consists of the following components: system simulation platform of the functioning of the automatic transfer switch, residential alarm panel and keypad, and communication module. The electric power supply of the vital consumers implies that an automatic transfer switch (ATS) is used which upon the disconnection as a result due to a fault, switches the vital consumers' connection to another alternate power source. When the Automatic Transfer System is triggered in the rapid response mode, as a result of a fault in the electric network, the transfer is performed only if the main source has been disconnected and the electric power reserve has the minimum value of the permissible operating voltage. The timer of the Automatic Transfer System is performed when the main source voltage level drops below a certain preset value called threshold voltage.

Also, Kitchener (2012) propose a wake-up timer for remote sensors and therefore trade frequency accuracy for reduced power consumption. The wake-up timer is constructed from a five-stage ring of inverters in which the switching speed is reduced using transistors that are always-off, or starved. Fabricated in a 0.35 μm process, the oscillator and its active load dissipate 80 pW at 1.5 Hz from a 1 V supply at 22°C.

Finally, Mohankumar (2012) proposes a timer circuit with an LDR control for day time operation. When the LDR is in light, it conducts and resets pin 12 of IC1 to be grounded. IC then starts oscillating with C1 and R2. After an hour, the Q12 output of IC1 turns high and energizes the relay. The phase line is connected to the common contact of relay so that when the relay energizes, it gives power to the AC socket through the NO (Normally Open) contact. Q12 output turns low after an hour and then turns on again after an hour.

2.3 Merits and prospects of the generator timer switch

This project of designing and constructing an automatic generator timer switch is very important as it automatically switches off a generator at a pre-determine time. This will help users not to inhale smoke (carbon-monoxide) and will also solve the inconvenience of manually switching off generators. This project makes use of locally available and cheap materials to construct the timer.

CHAPTER THREE

METHODOLOGY

This chapter discusses the method used to design and construct an automatic generator timer switch. This automatic switch has the ability to automatically switch off a generator at a preset time and also turns it off when its fuel runs low before the preset time. Below is a discussion of the design and construction.

Different sub circuits were interconnected to achieve the functionality of the overall system of the design. The block diagram below (figure 3.1) explains the concept of the whole system.

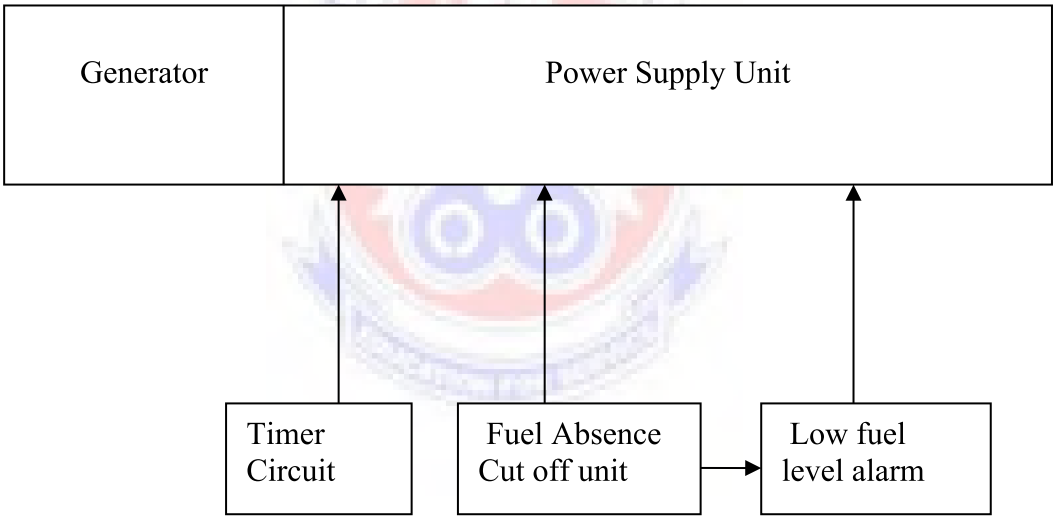

Figure 3.1 shows the Block diagram of an automatic generator timer switch

3.1 TIMER CIRCUIT

The timer circuit can give a time delay from 10 minutes to 24 hours. Six single-pole; single throw switches are provided for selecting the required time delay. Each time the switch is pressed it selects the required time delay and then when the timing cycle is complete, the relay energizes and remains latched till the circuit is reset. The circuit diagram is as shown below:

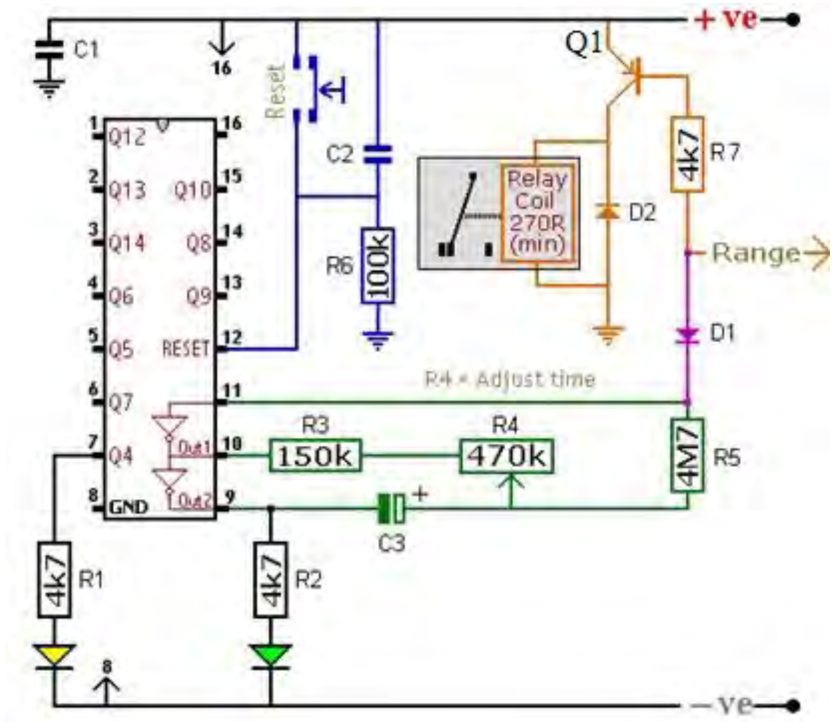

Figure 3.2 circuit diagram of the timer circuit

3.1.1 HOW THE TIMER CIRCUIT OPERATES

The main element of the circuit is the popular binary counter IC CD4060. It is the 14 stage oscillator also used as a binary counter as well as a frequency divider with an inbuilt oscillator.

The 4060 also has two inverters connected in a series across pins 11, 10 and 9. The IC together with R3, R4, R5 and C3 form a simple oscillator in the circuit. When the oscillator runs, the 14-bit counter counts the number of oscillations and the state of the count is reflected in the output pins. By adjusting R4, the frequency of the oscillator can be varied to achieve the required time duration. In other words, in order to obtain a longer duration, the given output pin must be high. When that pin goes high, it will switch the transistor and the transistor in turn will operate the relay. Some people use "Trial and Error" to set the duration of a circuit, however, a better solution is to use the following formula;

$$\text{Time } t = \frac{2n}{F} \text{ in seconds}$$

Where n is the selected output number

$$F = \frac{1}{2.5\,(R1XC1)} \text{ in Hertz}$$

R1 is the resistance at Pin 10 in Ohms and C1, the capacitor at Pin 9 in Farads the selected output number.

Ideally C3 should be non-polarized, but a regular electrolytic works. The time it takes for the Yellow LED to light MUST be measured from the moment power is applied. Although R1, R2 and the two LEDs help with the setup, they do not necessary aid the operation of the timer. The pin out of the IC is indicated by figure 3.3.

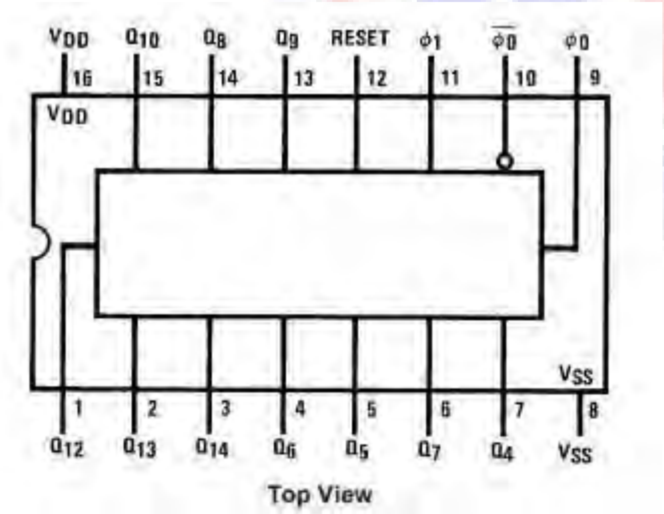

Figure 3.3 pin outs of the CD4060 IC

At power on, IC1 resets through C1 and R2 which therefore starts oscillation. Q4 output (Pin7) turns high first which is indicated by the blinking of Yellow LED. Each output of the IC then turns high as follows:

PINS	DURATION

Q8 (Pin 14)	8 minutes - 20 minutes
Q9 (Pin 13)	15 minutes - 45 minutes
Q10 (Pin15)	2 hours - 6 hours
Q12 (Pin 1)	4 hours - 12 hours
(Q13 (Pin2)	6 hours - 12 hours
(Q13 (Pin3)	8 hours - 24 hours

Table 3.1 showing the pins and their duration on the circuit board

When the output turns high, transistor T1 conducts and activates the relay. The relay therefore acts as a switch to disconnect the generator or any type of load connected to the Common and then closes contacts of the relay so that when the relay turns on, the load disconnects (switch off).

Components	Value	Quantity
Resistor	1k	4
Resistor	100k	1
Resistor	1M	1
Capacitor	0.1µf	1
Capacitor	0.22µf	1
Diode	IN4007	1
Light Emitting Diode, LED	Green , Red each	1
Momentary switch	Normally open	1
Transistor	BC457	1
Relay	12 Volts	1
Rotary	6 Volts	1

Rotary Switch	6 poles	1
Integrated circuit	CD 4060	1
Diode	IN 4148	1

Table 3.2 list of components on the timer switch

3.2 PETROL ABSENCE CUT-OFF UNITS

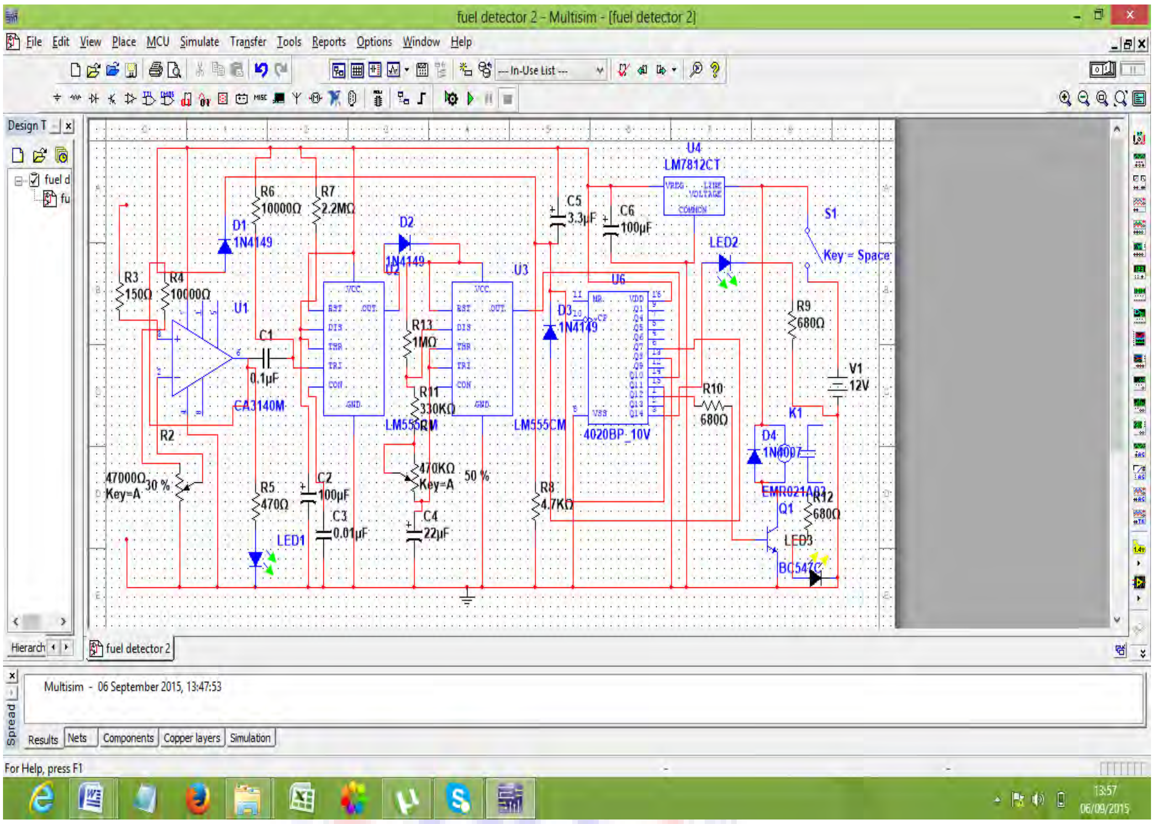

Figure 3.4 circuit diagram of petrol absent cut-off unit

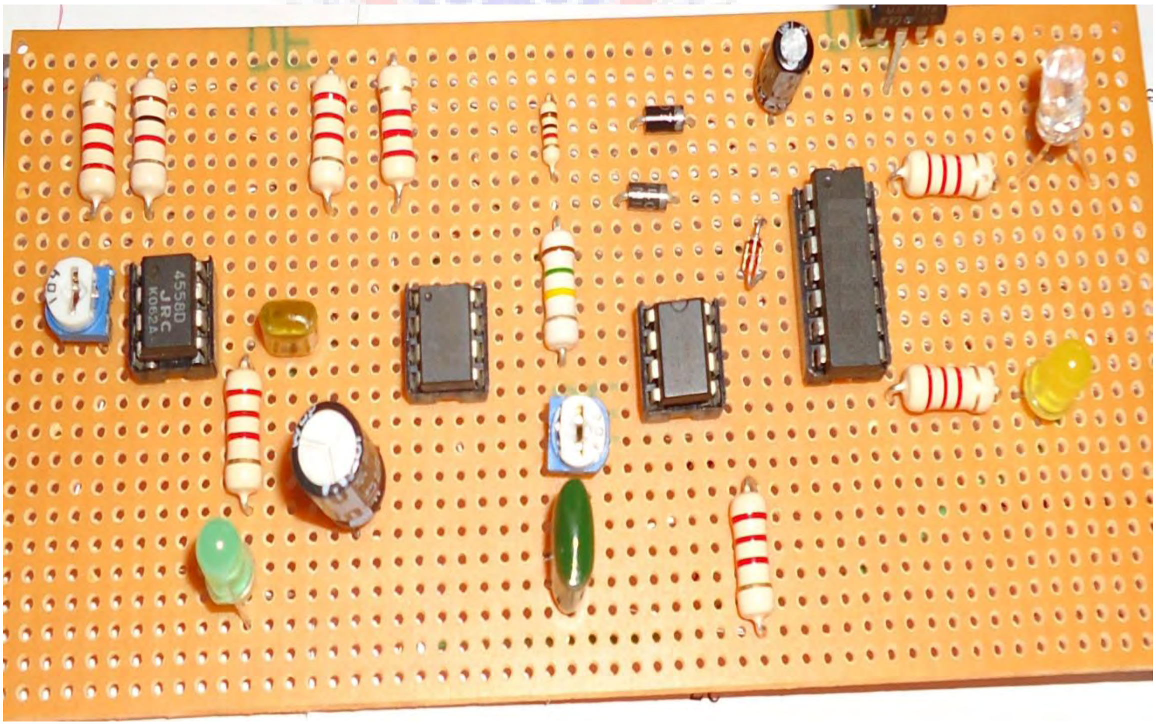

Figure 3.5 Picture showing circuit diagram of petrol absent cut-off unit

COMPONENTS	VALUE	QUANTITY
Resistor	150Ω	1
	10K	2
	470	1
	2.2M	1
	1M	1
	330K	1
	470K(Variable)	1
	47k(Variable)	1
	4.7K	1
	680	3
Diode	IN 4148	1
	IN 4001	2
Fixed Capacitor	0.1µF	1
	0.01µF	1
Electrolytic Capacitor	100µF/25V	2
	22µF/25v	1
	3.3µF/ 25V	1
IC 1	CA3140	1
IC2	555 timer	2
IC3	CD 4017	1
IC 4	7812	1
LED	RED	1
	YELLOW	1
	GREEN	2

RELAY	12V, THREE TERMINALS	1
FUEL METER	FUEL METER	1
FLOATING SENSOR	FLOATING SENSOR	1

Table 3.3 shows the component list for the petrol absence cut off unit

3.2.1 PRINCIPLES OF OPERATION FOR THE FUEL SENSOR CIRCUIT

The fuel sensor system consists of a tank-mounted float sensor and a current meter (fuel meter), which are connected in series. The float-driven sensor attached to an internal rheostat offers high resistance when the tank is empty. When the tank is full, the resistance decreases allowing more current to pass through the meter to give a higher reading which indicates sufficient level of meter. The fuel monitoring circuit works by sensing the voltage variation developed across the meter and activates the relay when the fuel level goes below the sensor probe. Its point A is connected to the input terminal of the fuel meter and point B is connected to the chassis of the generator. The circuit consists of CA3140 operational amplifier (op-amp IC1), two 555 timer ICs (IC2 and IC3) and decade counter CD4017 integrated circuit (IC4).

The op-amp IC (CA3140) is wired as a voltage comparator. Its inverting input (pin 2) receives a reference voltage controlled through VR1. The non-inverting input (pin 3) receives a variable voltage tapped from the input terminal of the fuel meter through resistor R1. When the voltage at pin 3 is higher than at pin 2, the output of IC1 goes high and the green LED (LED1) glows. This condition is maintained until the voltage at pin 3 drops below that of pin 2, when this happens, the output of IC1 swings from high to low, which sends a low pulse to the trigger pin of the mono-stable (usually held high by R3) through C1.

The output of IC2 is used to power the stable circuit consisting of timer 555 (IC3) through diode D2. Oscillations of IC3 are controlled by R6, R7, VR2 and C4. With the given values, the 'on' and 'off' time periods are 27 and 18 seconds, respectively. The pulses from IC3 are given to the clock input (pin 14) of decade counter CD4017 (IC4) and its outputs increase one by one. When the circuit is switched on, LED1 and LED2 glow if there is sufficient petro/diesel in the tank.

When the fuel goes below the sensor probe level, the output of IC1 goes low, LED1 turns off and a negative triggering pulse is received at pin 2 of IC2. The output of IC2 increases for about four minutes and during this time period, the clock pin 14 of IC4 receives the clock pulse (low to high) from the output of IC3. For the first clock pulse, Q0 output of IC4 increases and the green LED (LED2) glows for about 50 seconds. On receiving the second clock pulse, Q1 increases to light up the yellow LED (LED3) and triggers the relay to switch off the generator.

The IC5 (7812) is a positive voltage regulator that regulates the amount of dc voltage to be supplied to the various circuits of the fuel absence detector.

3.3 ALARM SYSTEM UNIT

The alarm in the fuel absence system of the timer triggers an alarm to alert the operator when there is shortage of fuel in the generator. The alarm unit is very important since there are two conditions under which the generator may go OFF.

1. When the switch OFF time set by the operator is due, the generator goes OFF without triggering an alarm.

2. On the other hand, when an alarm sounds before the generator goes off, it indicates that although the set time is not due there is shortage of fuel in the tank.

The sensor probe of the fuel absence alarm unit is placed at a reasonable position in the fuel tank to make sure that there is a small amount of fuel left in the tank to avoid breakdown of the engine of the generator.

Below is the circuit diagram of the fuel absence alarm unit.

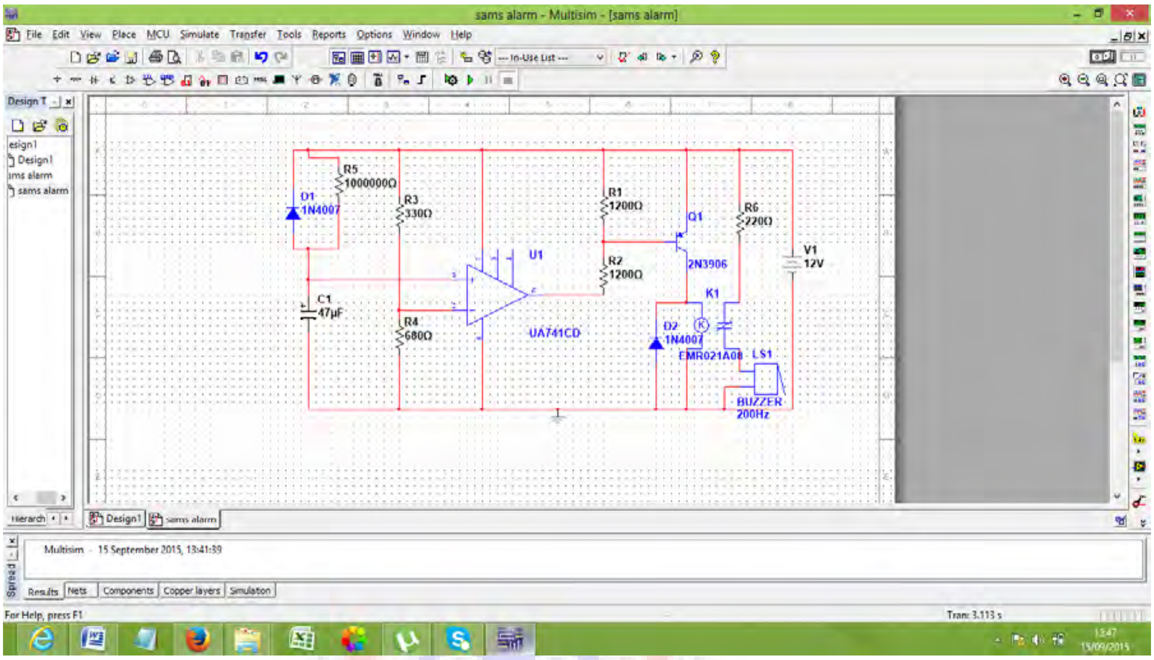

Figure 3.6 circuit diagram of fuel absence alarm unit

3.3.1 List of the components of the fuel absence alarm unit

COMPONENTS	VALUE/ NUMBER	QUANTITY
Integrated Circuit(IC)	UA741	1
Transistor	2N3906	1
Relay	12v/180Ω/10A	1
Capacitor	220µf/16V	1
Resistor (R_1)	1M (Variable)	1
Resistor(R_2)	330Ω ¼ W	1
Resistor (R_3)	680Ω 1/4W	1
Resistor (R_4,R_5)	1.2KΩ /1/4W	1

Resistor (R_5)	200Ω /1W	1
IC Seat	8 pins	1
Vero-board	Small size	1
Buzzer	12V buzzer	1
Diode	1N4007	2

Table 3.4 showing the components of the fuel absence alarm unit

3.3.1 PRINCIPLES OF OPERATION OF THE ALARM TIMER

The fuel absence detector circuit acts as an auto-turn OFF relay driver in which the relay turns ON as soon as the generator switches OFF as a result of fuel shortage. This switches on the buzzer to sound an alarm.

The relay turns OFF automatically after a delay of forty seven seconds which intern switches OFF the alarm.

When power is first applied to the circuit, capacitor (C_1) is fully charged, so the inverting terminal of the operational amplifier effectively is shorted to ground while the non-inverting terminal is held positive through resistor (R_2) and resistor (R_3). Under this condition, the operational amplifier (UA741) output is driven to saturation so that transistor one (Q_1) and the relay are both cut off. The capacitor (C_1) starts to charge exponentially through resistor one (R_1) as soon as power is applied to the circuit. After a preset delay time of 47 seconds, the inverting terminal voltage of the operational amplifier rises above that of the non-inverting terminal.

At this point, the operational amplifier comes out of positive saturation which in turn switches Q_1 to turn on the relay. The delay time is determined by the value of capacitor one (C_1). One microfarad of capacitor gives a time delay of a second therefore the 47μF capacitor gives a time delay of 47 seconds. Diode (D_1) is used in the circuit to rapidly discharge C_1 through the low value resistances of resistor two and three (R_2, R_3) when power is removed from the circuit to give a rapid reset action. The relay is 12v three terminal type (common normally open and the normally close) with current rating of 10A. The diode (D_2) is to de-energize the relay coil when power is switched OFF.

3.4 INTEGRATION OF ALL THE SUB CIRCUITS PUT TOGETHER

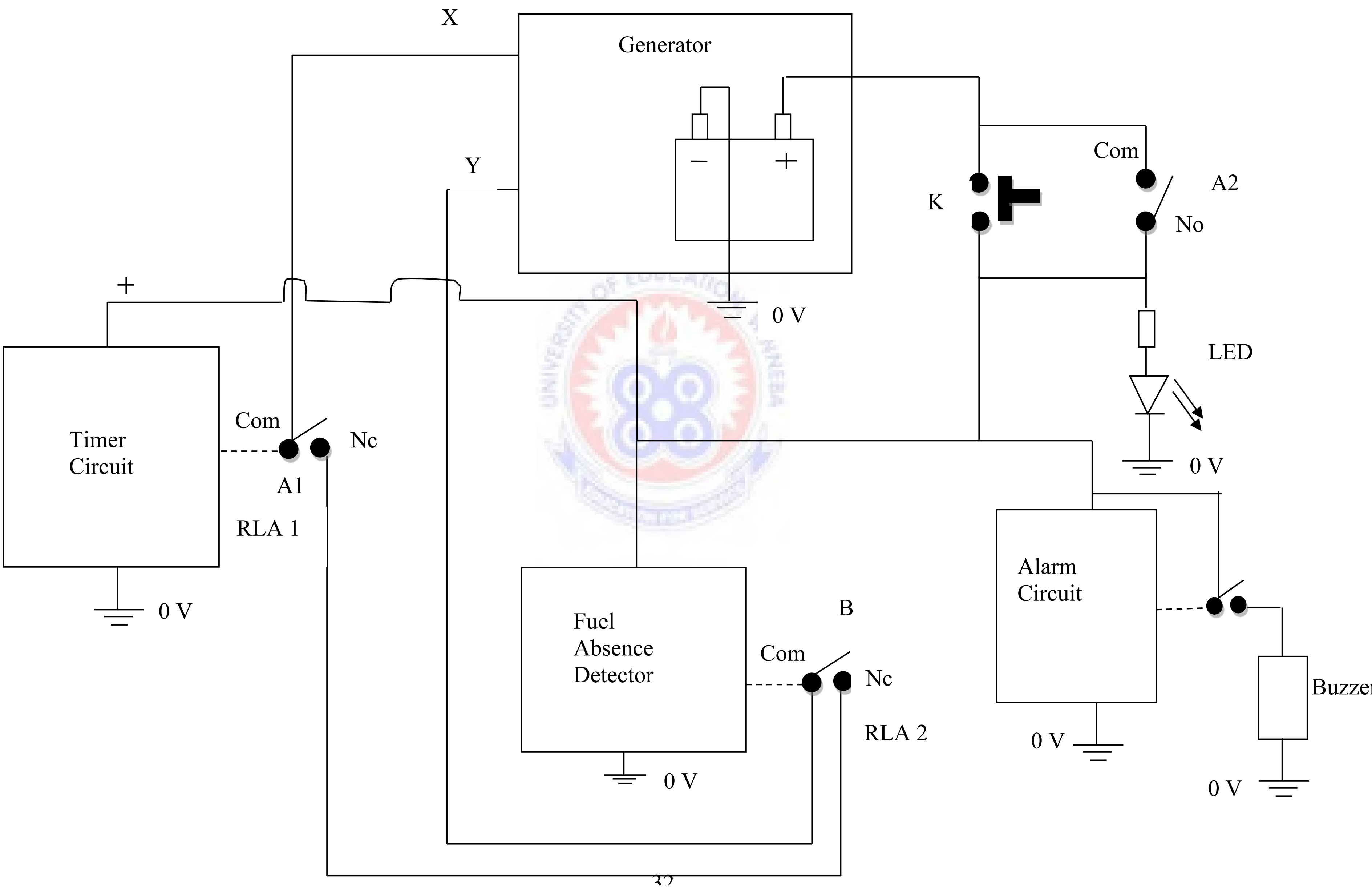

Figure 3.7: showing integration of all the sub circuits put together

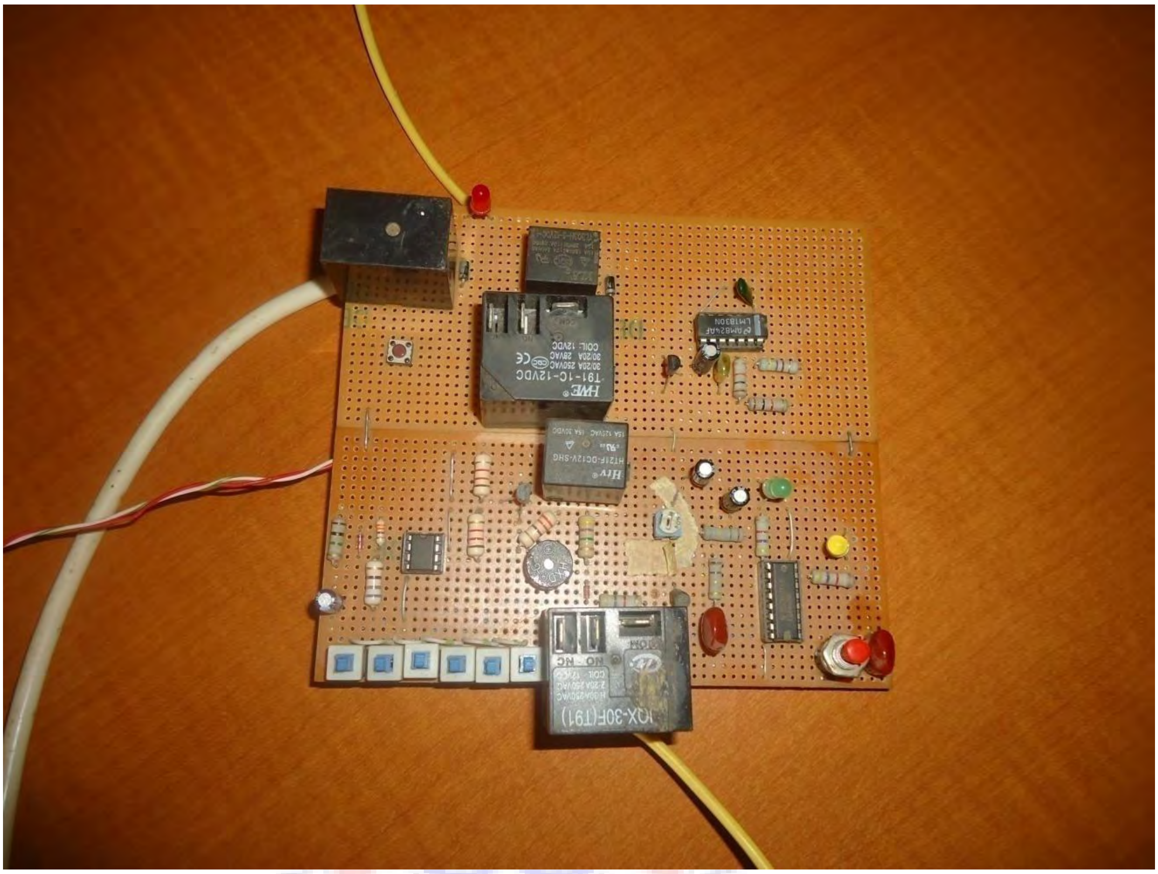

Figure 3.8 shows integration of all the sub circuits put together

3.4.1 Operation of all the sub circuits put together

All the circuits received their source of power from the starter battery 12V of the generator. When the switch "K" (momentary switch is pressed, it immediately closes the contacts of A_1 and A_2 (RLA_1) and since there is fuel in the generator, contact "B" (RLA_2) closes to start the generator.

The circuit receives power from the battery through A1, and then the light emitting diode (LED1) lights up to indicate that there is power in the circuit. When the set time set by the operator/ user is due, the contact of A1 and A2 open immediately and then the generator goes OFF. When the fuel in the tank get finished before the set time is due, the contact of "B" (RLA2) opens to stop the generator to avoid breakdown of its engine. An alarm sounds to indicate shortage of fuel. There are two wires (c,d) which are brought out from the generator, when these wires are shorted together, they start the generator but if they are opened, they stop the generator. These wires are connected to "X" and "Y" to have a connection with the circuit.

Moreover, a momentary switch is used in the circuit in order to stop current from the battery to the circuits when the set time is due.

CHAPTER FOUR

DATA ANALYSIS

4.1 Testing and Results

After the generator timer switch was designed and constructed, different tests were conducted to ascertain whether the desired objectives of the project had been achieved. The materials used for the construction were purchased and then tested with a digital multimeter. Those that malfunctioned were discarded and replaced. Although all the materials used had been tested to ensure that they functioned properly, the generator timer switch was tested after construction to make sure it functioned properly and seamlessly. The following are the records for the various tests performed on the timer switch.

4.2 Test results of the Generator Timer Switch

Stipulated time for generator to goes OFF	**Condition of the generator when the set time is due**	**Actual time the generator goes Off**	**Conditions the generator when the time is not due**	**State of alarm system when there is fuel in the generator**	**State of the alarm when there is no fuel**
After Exactly 1 hour	OFF	1 hour	ON	OFF	ON
After Exactly 2 hours	OFF	2 hours	ON	OFF	ON
After Exactly 3hours	OFF	3hours	ON	OFF	ON
4 hours After Exactly	OFF	4 hours	ON	OFF	ON
5 hours After Exactly	OFF	5 hours	ON	OFF	ON
6hours After Exactly	OFF	6hours	ON	OFF	ON

Table 4.1 showing the simulated test results the for the Generator Timer Switch

The Set time for the generator to goes OFF	Condition of the generator when the set time is due	Actual time the generator goes OFF	Conditions the generator when the time is not due	State of alarm system when there is fuel in the generator	State of the alarm when there is no fuel
After Exactly 1 hour	ON	1 hour 2 Minutes	ON	OFF	ON
After Exactly 2 hours	ON	2 hours 2 Minutes	ON	OFF	ON
After Exactly 3hours	ON	3hours 4 Minutes	ON	OFF	ON
4 hours After Exactly	ON	4 hours 4Minutes	ON	OFF	ON
5 hours After Exactly	ON	5 hours 6 Minutes	ON	OFF	ON
6hours After Exactly	ON	6hours 6 Minutes	ON	OFF	ON

Table 4.2 showing the Actual Results performed on the Generator Timer Switch

4.3 Discussion of the results

With respects to the various tests conducted, the stimulated results were accurate. The generator goes OFF as soon as the set time is due. When the set time is not due but there is fuel shortage, the generator goes OFF which prompts a buzzer to sound an alarm.

However, the result obtained from the actual generator timer switch was not precise. The generator does not go OFF the set time set for switch OFF is due. There were variations of 2 minutes to 6 minutes. The alarm system works perfectly as planned as it buzzes when the fuel level in the generator reduces to the lowest level allowed to indicate shortage in fuel.

Hence, the results indicate that the generator time switch works well and can be used to automatically switch on generators. It has time variations of between 2 minutes to 6 minutes but can be modified by choosing low tolerance components for the constructions.

4.4 Cost of the project

S/N	Components	Value/ Number	Quantity	Unit price GH¢	Total price GH¢
1	Resistor	Different values	16	0.20	3.20
2	Diode	1N4007	5	0.20	1.00
3	Diode	1N4148	2	0.30	0.60
4	Capacitor	100nF/100 V	7	0.40	2.80
5	Capacitor	47 pF	2	0.35	0.70
6	Switch	3 A/100 V	6	0.50	3.00
7	Relay	30A,250V, 12V Coil	3	4.00	12.00
8	Relay	10A/ 250 V, 12 V coil	2	2.00	4.00
9	Transistor	2N3906	3	0.50	1.50
10	Integrated Circuit (IC)	CD 4060	1	4.00	4.00
11	Integrated Circuit (IC)	UA741	1	1.00	1.00
12	Momentary Switch	Normally Open	2	0.50	1.00
13	Light Emitting Diodes (LED	Red, Yellow, Green	3	0.20	0.60
14	Bread Board	Small size	2	1.00	2.00
15	Lead		2 yards	1.00	2.00
16	Connecting Wires	Network cable	2 yard	0.50	2.00
17	Variable Resistor	100KΩ	1	0.20	0.20
18	Integrated Circuit (IC)	CA3140	1	2.00	2.00
19	Buzzer	12	1	1.00	1.00
20	Integrated Circuit (IC)	LM 555	2	1.00	2.00
	TOTAL GH¢			**20.85**	**46.60**

Table 4.3 showing the final cost of the project

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

No nation in the world can develop without electricity. The reality on the ground in Ghana presently is that, the demand for electricity exceeds generation of power. Thus, consumers experience both scheduled and unscheduled power outages. This has compelled most consumers to resort to the use of generators as a power backup source although the cost of running them is high. The designed and constructed generator timer switch is purposed to automatically switch OFF generators within a preset time set by users. Also, the automatic switch system switches OFF the generator before the set time is due when the generator runs out of fuel. There is an alarm system which is also incorporated into the switch to warn users when there is shortage of fuel in the generator.

From the analysis and testing of the project, the following conclusions are made:

1. The generator timer switch which was constructed with local materials was able to switch OFF the generator although not exactly at the pre-set time but within a variation of about two to six minutes
2. The device was able to switch OFF the generator when it detected fuel shortage.
3. When the generator was switched off due to shortage of fuel, a buzzer was prompted to sound an alarm.
4. The cost of production was low, since the generator switch was constructed using materials available on the local market.

As a result of the factors above, it was determined that the automatic generator timer switch worked properly.

5.2 Recommendations

From the results obtained with the use of the automatic generator timer switch, it will of much benefit to the general public.

The following courses of action are recommended for implementation:

1. The government of Ghana should encourage Ghanaians to embrace locally manufactured goods.

2. Special attention and funds should be given to technology and engineering students support their research work.

3. Exchange programs for technology/engineering students in Ghana should be given the opportunity to go for exchange programs at universities in more advanced countries.

4. Well-equipped and ultra-modern laboratories should be provided for departments of technology in universities and polytechnics in Ghana.

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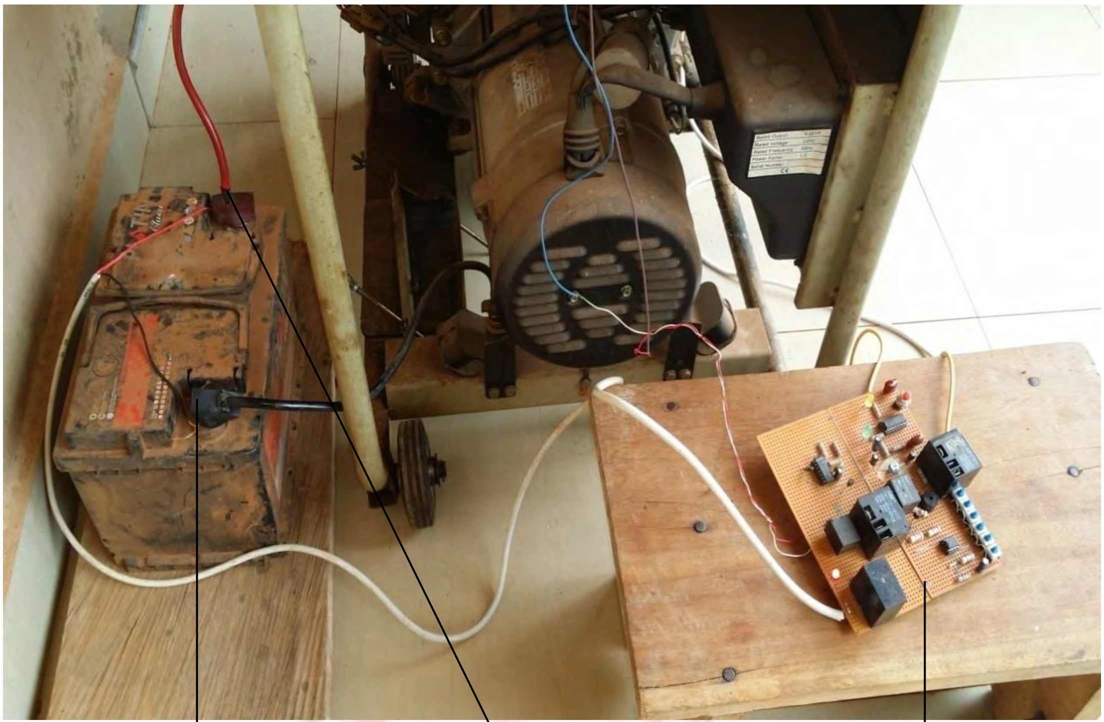
APPENDIX A



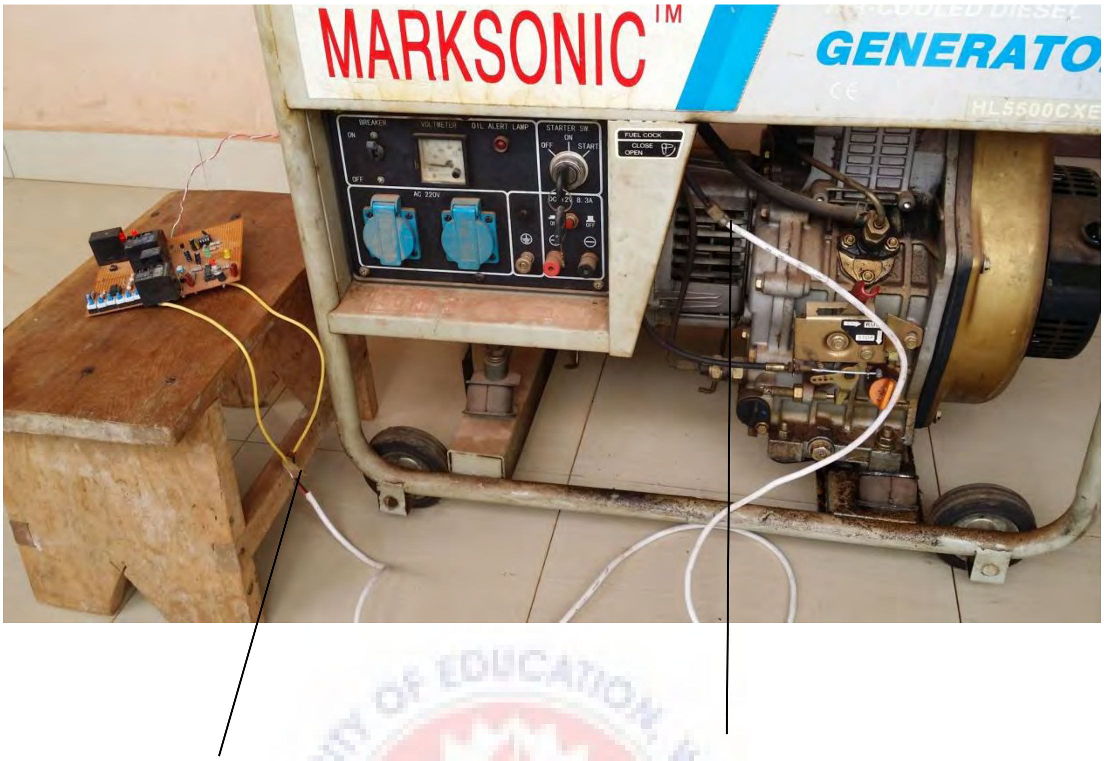
A picture showing the generator battery connected to the Timer Switch

Negative end of the Generator battery

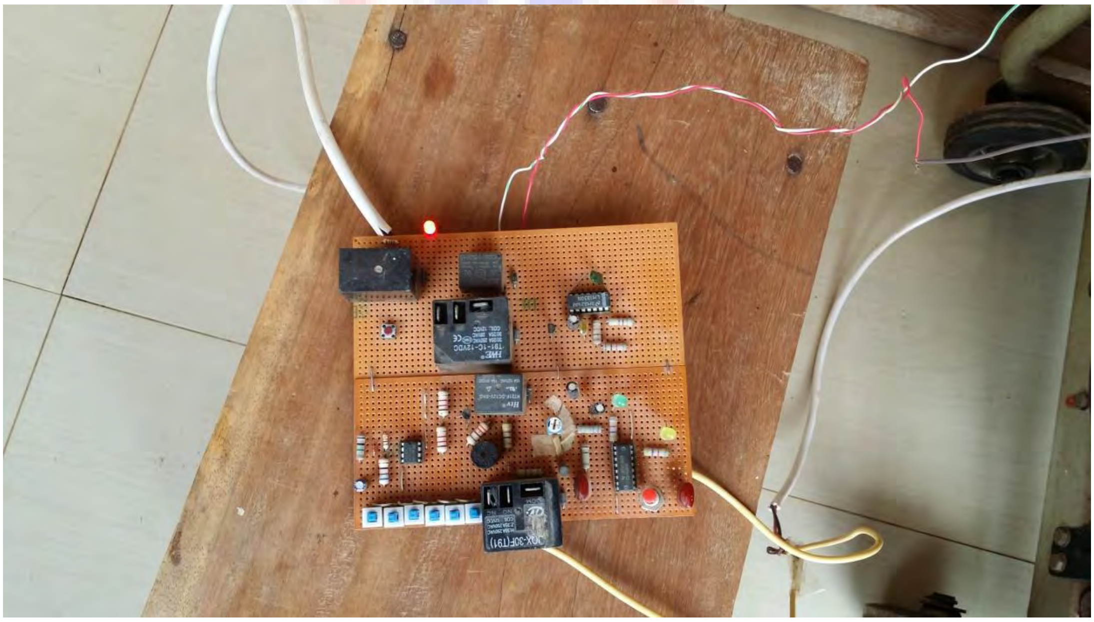
Positive end of the Generator battery

Timer Switch

A picture showing the Timer Switch Connected to the Generator Starter or Key to switch of the when the time is due and also and when the fuel finishes.



Cable or wires from the Timer Switch connected to the Generator Key



The Generator Timer Switch with the LED light on indicating the generator is working.

A Picture showing the Timer Switch Connecting wires into the fuel tank.

Timer Switch

Connecting wires from the fuel Absence section of the Generator Timer Switch going in to the fuel